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Agricultural Research Service

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Protecting Our Watersheds Through Research and Management

Challenges and Opportunities

Over 80 percent of our fresh water comes from precipitation that falls on watersheds and seeps into groundwater or flows into streams and reservoirs. Land use in the Nation's watersheds is complex and varied—ranging from crop production areas, rangelands, and pastures to forests and alpine meadows to urban areas.

How we manage the activities that take place on watersheds influences the quantity and quality of water available for domestic, industrial, agricultural, and ecological uses. There's an urgency, therefore, in developing sound management principles for agricultural watersheds if we are to guarantee a safe and dependable water supply.

The agricultural watershed research facilities of the Agricultural Research Service (ARS), U.S. Department of Agriculture (USDA), are among the most advanced of their kind in the world. Spread throughout diverse regions of the United States, these facilities permit scientists to evaluate the effects of many land management practices on water supply, floods, droughts, and water quality.

Over the many years most of the facilities have existed, researchers have collected extensive data that quantify how a watershed responds to agricultural activities. These data have also enabled development of new technologies for evaluating and managing water supply and water quality and for mitigating the effects of floods and droughts. New analytical tools developed through the ARS research program allow researchers to study how changes in climate, agricultural management, and land use affect the Nation's water resources. And finally, ARS watershed research facilities are used to test the environmental sensitivity of new agricultural management practices.

The Fundamental Issues

At the dawn of the new millennium, our Nation faces six major challenges regarding watersheds:

- Protecting life and property from floods
- Mitigating the effects of droughts and water scarcity
- Providing clean water
- Rehabilitating impaired watersheds
- Determining the effects of climate change on water resources
- Ensuring environmental and ecosystem health.

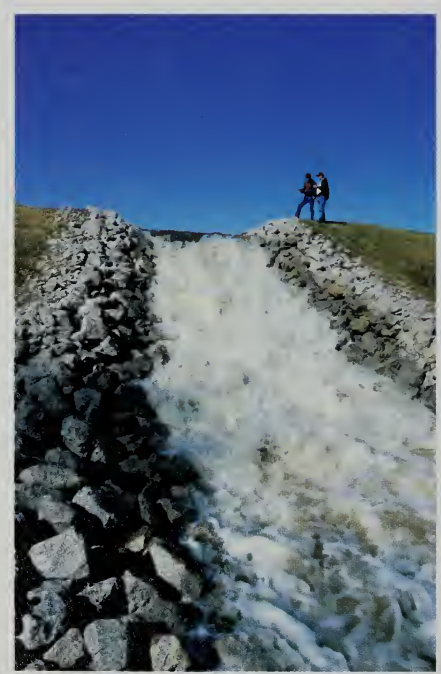
ARS is addressing these challenges through five areas of watershed research:

- Rehabilitating watersheds and managing floods
- Mitigating droughts and forecasting water supplies
- Enhancing water quality
- Restoring stream corridors
- Developing tools for managing watersheds and making policy decisions.

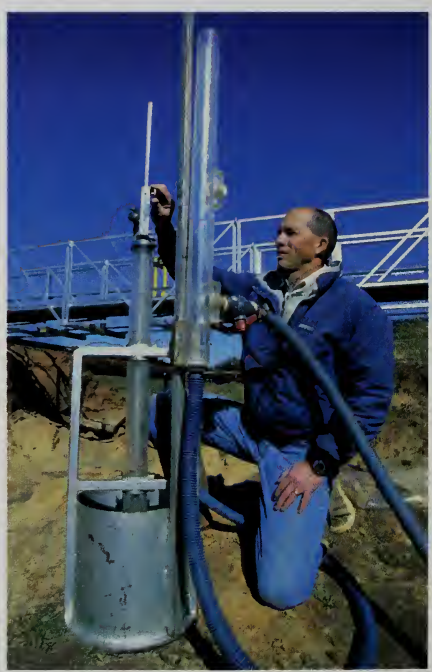
Rehabilitating Watersheds and Managing Floods

Vision— **Management of rural landscapes and stream systems that minimizes the effects of floods on life and property.**

An embankment breached from overtopping.



This rock chute safely transfers runoff to a lower elevation.



The jet test developed by ARS for measurement of soil erodibility is an ASTM standard.

Beginning 50 years ago, an extensive flood-control infrastructure was constructed by USDA's Soil Conservation Service* on small agricultural watersheds. More than 10,000 upstream flood-control dams and 5,000 grade-stabilization structures were built at an investment of $14 billion.

Now near the end of their planned life, more than 2,000 of the dams need rehabilitation—at an estimated cost of $540 million. Over 650 pose a threat to public health because of structural deterioration and urban development downstream. Upstream, changes in land use, such as urban development, have increased the risks of severe and frequent flooding.

To reduce the severity of floods and mitigate their effects, ARS scientists are

- developing standards for designing economical, safe, and environmentally appropriate flood-control structures
- devising economical methods for rehabilitating aging structures
- developing techniques for extrapolating extreme-event data from fields to watersheds
- quantifying the frequency of floods from agricultural lands, using long-term hydrologic data
- creating computer models for estimating the effects of land treatment on flood flows
- developing new land management practices that minimize downstream flooding.

*Today called the Natural Resources Conservation Service.

Mitigating Droughts & Forecasting Water Supplies

***Vision*—Watersheds are managed to reduce economic losses from droughts and the risk of water shortages.**

Grassland depleted by drought.

Taking measurements of groundwater depth in a floodplain aquifer.

Water scarcity may be the most critical water problem of the 21st century. By 2050, water stress or water scarcity will affect about 45 percent of the world's population. Droughts can be more devastating to communities than floods because they can persist for years and their economic costs are widespread.

Droughts set up strong competition for water between agriculture and other users. Because of community concerns, the base flow of streams must be maintained during droughts to ensure healthy aquatic ecosystems.

To reduce the adverse effects of droughts, ARS researchers are

- using weather and climate data to estimate the frequency and severity of droughts
- measuring how drought affects the amount of water flowing from agricultural watersheds
- determining how reduced stream flows affect aquatic ecosystems
- developing computer models to assess how land management and precipitation patterns affect water supply and agricultural production.

Enhancing Water Quality

Vision— **Adoption of watershed management practices that protect water resources from degradation by agricultural activities.**

A water quality sampling instrument.

A runoff-measuring flume with a traversing slot sediment sampler.

Land use and farming practices affect the quality of groundwater and surface water. For example, sediment loss from agricultural land can be destructive in water impoundments, such as reservoirs, by reducing the amount of water held in them. Runoff of fertilizers can hasten the aging of bodies of water. Pesticides can get into surface water and groundwater supplies. In animal-based agriculture, manure and pathogens can potentially damage water quality. Elevated stream temperatures can harm cold-water life.

To protect water resources from degradation, ARS scientists are

- developing ways to predict the movement of agricultural chemicals from fields through watersheds to bodies of water
- improving our understanding of the chemical interactions taking place within a stream system
- measuring how land management practices contribute to the fate and transport of contaminants in agricultural watersheds
- identifying watershed management practices that protect and enhance the quality of groundwater and surface water
- understanding how land management affects stream sediment and temperature.

Restoring Stream Corridors

Vision— **Watersheds are managed in a manner that sustains agriculture and protects wildlife habitat, soil and water resources, and aquatic ecosystems.**

A forested riparian area.

Observing changes in channel geometry and stream corridor habitats caused by water rushing over a headcut.

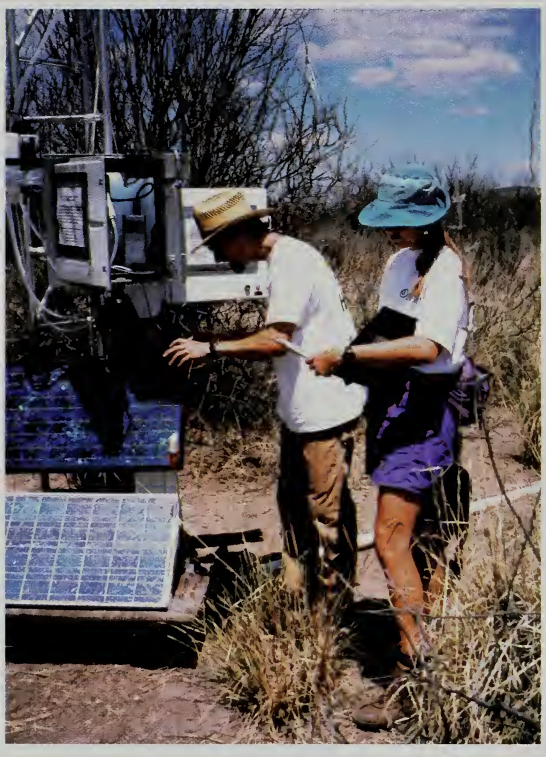
Sedimentation and the accumulation of excess nutrients degrade streams and water quality. If we are to enhance the ecological and recreational value of the Nation's watersheds, we must restore our streams and aquatic ecosystems. Addressing these concerns while sustaining agricultural production will require careful, scientifically sound management of uplands, wetlands, riparian zones, streams, rivers, lakes, and other aquatic environments.

To restore degraded stream corridors, ARS scientists are

- measuring how water, soils, vegetation, and watershed characteristics affect the sustenance of riparian systems—the banks of a natural course of water, like a stream or river
- analyzing how streams respond to systems for managing riparian zones and practices for stabilizing streams
- developing new conservation practices to restore streams in order to preserve riparian and aquatic ecosystems
- assessing whether new watershed management systems actually sustain streams
- finding ways that lessen the effects of natural disturbances, like fires and weed invasion, on watersheds and riparian systems.

Developing Tools for Managing Watersheds and Making Policy Decisions

***Vision*— Analytical tools are used to effectively manage watersheds and make informed water policies.**



Servicing micrometeorological instruments.

Snow-dominated, high-relief watersheds are collection sites for information on runoff and erosion.

Public agencies are required by law to make policy and regulatory decisions regarding watershed management that affect the Nation's water quality and water supply. Often these decisions must be made subjectively, because technical knowledge is lacking and planning tools are inadequate.

Balanced decision-making will require data gathered over the long term from agricultural watersheds, as well as technically sound decision-support systems. New technologies, such as remote sensing techniques for characterizing landscapes, will improve policy-making and add efficiency to watershed management.

To promote sound watershed management and water policies, ARS scientists are

- assembling regional and national data from watersheds that measure how climate, soils, geology, topography, land use, and land management affect water quantity and quality

- developing computer models for analyzing movement of water and contaminants in watersheds of various sizes

- developing innovative, cost-effective techniques based on remote sensing, acoustics, and weather radar for obtaining data about snow cover, soils, and vegetation for use with planning tools, such as watershed computer models

- developing comprehensive decision-support systems for policymakers that integrate watershed models, databases, geographic information systems, and remote sensing.

ARS Watershed Research Program

The mission of the ARS watershed research program is to develop new watershed-scale technology for efficiently managing water resources and for protecting the population from the effects of floods and droughts, while preventing degradation of water supplies and aquatic ecosystems.

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For additional information, visit the ARS watershed web site: http://ars-boi.ars.pn.usbr.gov/watershed/

While supplies last, single copies of this publication may be obtained at no cost from USDA–ARS, Grassland, Soil & Water Research Laboratory, 808 E. Blackland Rd., Temple, TX 76502.

Copies of this publication may be purchased from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161; telephone (703) 605–6000.

ARS Mission

As the principal in-house research arm of the U.S. Department of Agriculture, ARS conducts research to develop and transfer solutions to agricultural problems of high national priority and provides information access and dissemination to—ensure high-quality, safe food and other agricultural products, assess the nutritional needs of Americans, sustain a competitive agricultural economy, enhance the natural resource base and the environment, and provide economic opportunities for rural citizens, communities, and society as a whole. For more information about ARS, visit the web site at **http://www.ars.usda.gov/**